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Comparison of the Marginal Gingival Fluid of Full Cast Gold Crowns Versus Full Cast Albus IV Crowns

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COMPARISON OF THE MARGINAL GINGIVAL FLUID OF FULL CAST GOLD CROWNS VERSUS FULL CAST ALBUS IV CROWNS

by

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VITA

The author, Hanne T. Sweetnam, was born in Deerfield, Illinois, November 12, 1936. She was the daughter of Aksel T. and Else J. (Hendricksen) Petersen of Sjæ lland, Denmark.

After graduation from Highland Park High School in 1954 she studied at Valikilde near Copenhagen, Denmark for one year. On her return to the United States she served as a dental assistant, gained accreditation and following the graduation of her husband, George, from Loyola University School of Dentistry in 1960 assisted in the establishment of his office and practice.

In 1967 she entered Joliet Junior College as a pre-dental student. After completion of her work there and one year at Lewis University, Lockport, Illinois, majoring in biology, she also entered Loyola University School of Dentistry, Maywood, Illinois. While attending dental school she was one of the first women to join the dental fraternity, Xi Psi Phi. She was granted her degree of Doctor of Dental Surgery in 1974. Upon

graduation she was recognized by the International College of Dentists who named her as the student who made the greatest advance within her class.

Both before and after graduation she contributed table clinics at Loyola Dental School, the Chicago Dental Society Midwinter Meeting, and the Illinois State Dental Society state meeting.

She has also joined and is a member in good standing of the Academy of General Dentistry, a member of the American Dental Association, an alumni member of Xi Psi Phi, a member of the Will County Dental Society, and a member of the Will County Study Club.

In 1975 she reentered Loyola University Dental School, Maywood, Illinois for postgraduate clinical speciality training in Fixed Prosthodontics and the graduate program in Oral Biology. She is also currently a clinical instructor at Loyola University Dental School.

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CHAPTER I

INTRODUCTION AND STATEMENT OF PURPOSE

Restorative dentistry is concerned with many areas, not the least of which is gingival health. It is known one of the criteria for restorative success is a healthy periodontium. Marginal gingivae gives the first clue when inflammatory processes are present.

Recognition of the detrimental effect of restorative procedures, restorative materials, and restoration contours is a clinical reality. The resultant inflammatory effect of placement of crowns into the marginal gingiva has long been observed. Recently a fluid meter, The Harco Periotron,* has been developed which allows for computerized measurement in determining the degree of this inflammation. This instruement is a gingival crevicular fluid meter which electronically measures minute fluid volumes. This is done by a reduction in capacitance between two sensors when in contact with a standardized filter strip containing the fluid to be measured.

*Periotron: trade name designated to the gingival crevicular fluid meter utilized in this research. The instrument was developed, manufactured and is distributed by Harco Electronics, Ltd., Winnipeg, Canada.

The literature is replete with observations relating increases in marginal gingival fluid to increased inflammation (Krasse and Egelberg 1962, Mann 1963, Egelberg 1964, and Löe and Holm-Pedersen 1965). With the use of the Periotron the fluid increase can usually be detected before clinical signs are evident.

In conjunction with marginal integrity one must also be concerned with the development of innocuous crown contours.

Gold alloys have long been the material of choice for crown and bridge dental restorations. They have been proven to be inert in vivo, tissuephillic, burnishable, strong and durable. It has been traditionally accepted, with all other procedures remaining equal, and of all the materials available, gold restorations have offered the patient the most acceptable marginal integrity and tissue response.

In 1974 the increase in the cost of gold and other noble alloys stimulated interest in the use of other precious and base metal alloys. It is therefore the purpose of this investigation to compare the gingival response of the precious metal alloy, Albus IV, to that of Type III gold alloy.

CHAPTER II

REVIEW OF THE LITERATURE

Historical Perspective

The interest in the histology and physiology of the gingival tissues can be traced to the writings of G. V. Black (1887). He histologically evaluated the periodontal tissues and postulated there was in these tissues "a very peculiar system of cells closely resembling those of the lymphatics." He saw numerous "glands" near the gingival area but finding no ducts, stated, "close clinical examination makes it apparent that there is a slight secretion at this point that is not quite satisfactorily explained even yet by microscopic study of the part."

In 1899 after intensive histologic evaluation of this area, he not only refuted his own postulation but that of Serres' (1817) gingival glandular description. Black (1899) theorized and attempted to histologically show evidence of a deep plexus of glands, clustered among the principle fibers, which encircled the root of the tooth, becoming "less thick progressively toward the apical end."

As research and study continued Böedecker and Cahn (1931) in a dental research item refuted previous reports of Black (1899). They found no histologic evidence of gingival glands.

Contemporary Concepts

A perusal of the gingival sulcus on dogs by Waerhaug (1952) attested to the "transudation of fluid." One hour after placement of India ink in healthy tissues he noted emigration of leukocytes and increased flow. Most of the ink particles were removed after two hours. He reasoned saliva could not enter the sulcular area and "In healthy pockets where a normal epithelial cuff is closely fitted around the tooth to the gingival margin, the secretion is rather minute."

In a study to examine the "sterility" of the gingival pocket Waerhaug and Steen (1952) histologically observed the tissue reaction after the introduction of pathogenic bacteria into bacteria free crevices. The observation was for a forty-eight hour period. Their conclusions were: 1) "From all pockets there is a constant flow of cellular elements and tissue fluid," 2) the sulcular crevice in healthy, calculus free mouths is sterile, 3) epithelial necrosis and connective tissue inflammation generated by bacteria in the crevice, forms an exudate.

One of the first studies to examine the permeability of the human crevicular tissues was initiated by Brill and Bjorn (1959). They introduced sodium fluorescein (orally administrated) into the body and examined crevicular tissues for differentiation from other oral and nasal epithelium. Their result demonstrated "the epithelial lining of gingival pockets are generally permeable to the molecules of Fluorescein sodium whether clinically healthy or inflamed." More fluorescein was, however, recovered from inflamed gingiva. The difference which existed between other oral epithelia and gingival tissues could be 1) "The passage of fluid into pockets is the result of inflammation in surrounding tissue, 2) it is the result of a normal property inherent in pocket epithelium, permitting it to act as a permeable membrane like some other epithelial membranes in the body." The significance of their paper was the opening of the question "should shifting of fluid from sub-epithelial compartments thru epithelium be physiologic or pathologic?"

With continued interest in crevicular fluid flow Brill and Krasse (1959) presented an investigation demonstrating increased stimulation causes increased fluid flow. Molecules of sodium fluorescein, from the gingiva of healthy dogs, were recovered in increased amounts after mechanical (brushing) stimulation. Approximately ten

minutes after initial incitement ended, this increased flow rate returned to normal. They suggested when a vascular bed was stimulated, one reaction of arterioles was dialation accompanied by increased pressure. "At the same time an increased permeability of the vessels may occur allowing plasma to escape more freely." This vascular reaction was usually seen in the early stages of inflammation. Another theory they postulated related to the connective tissue. Thissue manipulation may cause the gel-like structure of the connective tissue to become edematous, dissolving the ground substance, thus a sol is created out of the gel substance. Their conclusions were "Although reactions in the vessels, the connective tissue, and the epithelium have been mentioned seperately they are not mutually exclusive. On the contrary they seem to be intimately bound up with one another and it is highly probable that they should occur together under the experimental conditions applied in this study."

Brill (1959a) now presented an inquiry into the effect changes of capillary permeability would have on the gingival crevicular fluid flow. He investigated the effect related to histamine, mechanical stimulation, and inflammation. Positive results of increased amounts of the protein-bound Evans' blue, from these stimuli, led to the

statement: "This means that the permeability of capillary walls subjected to these stimuli has increased. From this study can be learned that some proteinacious material leaving 'resting' vessels even passes through connective tissue compartments and pocket epithelium when tissues are clinically healthy."

Again researching the flushing action of crevicular fluid Brill (1959b) placed charcoal particles of known size (2μ to 10μ) into the gingival sulcus of dogs and observed the fluid. As the fluid flow increased and removal of the particles was evidenced he reasoned: "The flow of tissue fluid from sub-epithelial structures of marginal gingiva is able to remove particulate matter, including bacteria, from gingival pockets."

Brill (1959c) in this survey postulated the bacteriocidel effect of fluid flow. After stimulation of tissues by vigorous chewing of paraffin he reported an increase in crevicular fluid. By using the ninhydrin staining technique (specific for α amino groups) he was also able to disclose the presence of amino acids. He concluded: "When gingival structures are stimulated by chewing, the antimicrobial effect may be increased, because mechanical stimulation of the gingival vascular bed stimulates escape of fluid from the vessels and plasma contains several antimicrobial substances."

In 1961 Gavin and Collins questioned the sterility of the gingival crevice as described by Waerhaug and Steen (1952) and Brill (1959c). They theorized "The entry of organisms into the crevice is favoured by the capillary action of the crevice, by the trauma and movement of mastication, and by the constant bathing of the crevice by saliva with its extremely numerous organisms."

In another study Collins and Gavin (1961), based on previous studies by Brill (1959c) investigated the possibility of antimicrobial action in the crevicular fluid. Filter strips inoculated with gingival fluid were placed in bacterially impregnated and pure blood agar dishes. All strips evidenced bacterial growth and in no instance was there any "demonstrable bacteriostatic or bactericidal effect." The conclusions of the authors were "to question the evidence supporting the belief that the clinically healthy gingival crevice, free from calculus or deposits, is as a rule, sterile. (Waerhaug, 1952; Waerhaug and Steen, 1952)."

In 1961 Löe designed an experiment to histologically examine the cellular content of the crevicular fluid from clinically normal gingival tissues. His purpose was to investigate 1) the turn-over rate of epithelial cells, and 2) the presence of leukocytes in the gingival tissue fluid. The tissues of forty-nine gingival areas were sealed with an alcholic solution of colophony (rosin)

followed by placement of acrylic crowns filled with surgical cement and locked in place with amalgam. Results from a short term (1-6 hours) study evidenced neutrophilic leukocytes within the epithelial cuff. On a long term (12-48 hours) investigation the appearance was basically the same, however, "leukocytes were more frequently found in the epithelial layer." The pocket area also contained desquamated epithelial cells and neutrophilic leukocytes. These increased proportionately with an increase in time. Loe thus hypothesized "the view that the epithelial cuff is constantly renewed." He also stated "The presence of neutrophilic leukocytes within the epithelial cuff and the accumulation of the same cells in the pocket indicate that they migrate through the epithelial lining under physiologic conditions." It was also his observation "there is a continuous transudation of tissue fluid into clinically normal gingival pockets."

The precept of the reduced sodium/potassium ratio in damaged tissues resulted in an inspection by Krasse and Egelberg (1962). They postulated a decrease in this ratio would indicate strongly, gingival fluid was an inflammatory exudate. Clinically healthy gingival fluid and chronically inflamed tissue were studied. Their scrutiny evidenced a proportional decrease in the sodium/potassium ratio. It was their reasoning "intracellular

potassium is added to the extra-cellular fluid on its way out into the gingival pocket." This reaction in clinically healthy gingival fluid suggested further "gingival pocket fluid cannot be regarded as a simple filtration product but rather as an inflammatory exudate."

Harvey (1962) placed amalgam alloy particles (0.25mm - 1.0mm X 0.1mm - 0.25mm) in the gingival crevice of dogs. The alloy also was placed in gingival crevices on humans who had orthodontic extraction requirements. The alloy (macromolecular in size) was completely eliminated, usually within a twenty-four hour period. The author theorized this was due to a physiologic process. He particularly supported previous studies (Brill and Krasse 1958, Brill and Bjorn 1959, and Brill 1959b) suggesting the method of elimination was "a physiologic flow of tissue fluid from the crevice." He further stated "such evidence contributes to the belief that the normal gingival crevice maintains its hygienic state by constant flushing with tissue fluid which is increased as a result of an acute inflammatory response to irritation."

Egelberg (1963a) assayed the cellular content of gingival fluid from clinically healthy and chronically inflamed gingival pockets. The cells (epithelial, polymorphoneuclear leukocytes, lymphocytes, and bacteria) were observed in all samples. There was, however, an increased amount of bacteria and disintegrated leukocytes from

the chronically inflamed gingiva. The finding of the same type of cells in both types of fluids "substantiates the suggestion (Krasse and Egelberg 1962) that the fluid in healthy pockets be regarded as an inflammatory exudate."

In a two-part research Egelberg (1963b) analyzed gingival flow before and after topical histamine application in 1) humans to determine the possibility of an increased outward crevicular flow and 2) dogs to determine heightened capillary uptake from an inward flow. Histamine was used because of its proven ability to cause an increase in blood capillary permeability. Results indicated a significant increase in fluid flow due to topical application of histamine. Histologically, topical application also demonstrated increased permeability of the capillaries of the gingiva. It was, however, inside the crevicular epithelium only. No penetration into the attached gingiva was observed. The results of the study refuted previous (Waerhaug 1955, Brill 1959) investigations suggesting a protective seal in the crevicular region. It was the opinion of the author that further research of crevicular diffusion was required.

As the controversary of whether the crevicular fluid is a transudate or an exudate continued, Mann (1963) collected fluid from 307 areas in 27 patients and correlated this fluid with pocket depth and gingivitis. This fluid was able to be assayed as the patients had received

(orally) a 5 grain capsule of fluorescein sodium. There was a 96% evidence of fluid presence. Results indicated a positive correlation between pocket depth, gingivitis, and fluid flow. A conclusion of this probe suggested the commutuality between inflammation and fluid flow is more interrelated than between pocket depth and fluid flow. He concluded by supporting the findings of Krasse and Egelberg (1962) "the fluid could not be regarded as a transudate of interstitial fluid but should be considered as an inflammatory exudate."

By 1964 most of the previous searches had only subjectively graded the degree of inflammation in gingivae. Egelberg (1964) investigated gingival exudate measurements quantitatively correlated to inflammatory cell infiltrate and the inflammatory state of the gingiva. Using filter strips and a ninhydrin staining technique a series of tests on dogs and humans were preformed. Results intimated a high correlation between inflammation (histologic) and fluid values. He also determined a higher degree of fluid collection in the gingival papilla. He thereby postulated "gingival exudate measurements can be considered a method which fulfills rather great demands in regard to objectivity and sensitivity. With this method (measurement by filter strips) at hand increased possibilities to study the effect of various factors on inflammation of the gingiva have probably been achieved."

A paper by Weinstein and Mandel (1964) presented a pertinent and exhaustive review of the literature and investigations completed to this date. Their objective was to focus attention on the role crevicular fluid played in the biology of the gingival sulcus. Recent studies alluded to eitologic factors in periodontal disease and calculus formation. A concise report of 1) composition of gingival fluid, 2) its productive mechanism and, 3) chemical importance was presented. It was their premise the production of the crevicular fluid was a specifically altered transudate. They postulated this may occur by 1) the shedding of the epithelial lining cells which may add "intracellular contents to the transudation of this region," 2) the cells may engage in ionic transport themselves, or 3) there could be a cellular fluid exchange through micropores in the cell wall. They concluded by suggesting a return to considering supra-gingival calculus as primarily salivary in origin and sub-gingival calculus from the serum. The fact they have similiar compositions suggested "a comparability in mechanism of formation rather than a common source of raw material."

In a well controlled study Löe and Holm-Pedersen (1965) investigated the absence or presence of fluid from normal and inflamed gingiva using both the extra and intra crevicular methods of collection. Biomicroscopic examin-

ation of capillary reaction to the filter strip placement deep in the crevice revealed compression and subsequent clinical anemia. Their results evidenced no fluid flow in a significant number of areas of clinically healthy gingiva. When mild inflammation was present, fluid flow increased. Their opinion was "1) crevices of normal human gingiva do not exhibit flow of fluid" (in disagreement with Brill 1962) 2) fluid flow is indicative of inflamed tissue and can be ascertained prior to clinical observations. Also flow can persist "some time after clinical inflammation has sub-sided" and 3) "gingival fluid is an inflammatory exudate and that the absence or presence of fluid may represent the definite clinical criterion in the refined distinction between normal and inflamed gingiva."

Oliver et al. (1969) presented a paper where 53 patients had gingival (labial and buccal) areas scored, exudate samples collected, and microscopic examinations performed. Correlations between gingival inflammation, fluid exudate, and gingival index (Löe and Silness-1967) were effectuated. Data indicated a relevant correlation between gingival index and exudate measurements. When there was no clinical evidence of inflammation there was very little or no exudate.

A correlation of (histologic) inflammatory changes, fluid flow, and clinical gingival health (Ramfjords

criteria) was performed on a "group" of patients by Orban and Stallard (1969). It was suggested a modification (by enzymes, chewing, massage, hormones) of intercellular cementing substance of the sulcular epithelium increased the permeability without necessarily altering the inflammatory condition. A statistical analysis of the results suggested no correlation between inflammation and increased fluid flow. They did, however, reveal a high degree of correlation between plaque scores and histologic evaluations. They concluded therefore, plaque scores to be a better indication of inflammatory status.

Recent Research

Golub et al. (1974) presented a study to determine if collagenolytic activity was detectible in sulcular fluid and if this could be related to gingival disease. Collection, on filter strips, of crevicular fluid was measured, while recordings of gingival index and pocket depth were made. Each filter strip was then placed on a treated collagen gel. Results exhibited gingival crevicular fluid samples which had no visible lysis originated from gingiva with a mean gingival index of 1.07 $\pm$ 0.13mm, a mean pocket depth of 2.38 $\pm$ 0.26mm, and a mean crevicular fluid value of 0.16 $\pm$ 0.02µl. Positive activity was seen (15.5 $\pm$ 3.4%) in gingiva with pocket depth means of 2.61 $\pm$ 0.26mm and gingival index means of 1.44

± 0.21mm and fluid values of 0.26 ± 0.05µl. Their conclusions were "Collagenolytic activity in human gingival crevicular fluid tends to be associted with gingiva exhibiting increased inflammation."

Borden et al. (1974) proposed the I (intra-crevicular) method of fluid collection was better. He was of the opinion this method did not stimulate an increased flow. "Results indicated the E (extra-crevicular) method is unsatisfactory for the slightly inflamed gingival crevice since gingival crevicular fluid may have difficulty flowing out of such crevices." He further stated: "Repeated I measurements gave similiar gingival crevicular fluid rates" also "Repeated I measurements did not significantly stimulate fluid flow."

Alfano (1974) proposed a theory which explains whether gingival fluid is a physiologic transudate or an inflammatory exudate. Based on the premise fluid may arise by two distinct mechanisms: 1) the generation of a standing osmotic gradient induced by macromolecular bacterial by-products of the subgingival plaque, and 2) the initiation of classical inflammation. He then presented a theoretical model for transepithelial fluid movement. This model answers his first premise, ergo his statement: "Gingival fluid may progress, at different times or in various areas of the mouth, from an initial osmotically modulated exudate to a secondary inflammatory

exudate, with consequent alterations in its composition."

In 1974 Mörmann et al. investigated the resultant gingival fluid flow and plaque formation from subgingivally placed gold inlays. Eight subjects, each with one polished and one roughened gold inlay, were evaluated. The flow rate and plaque indices, after the eighty-five day test, were scored and analyzed. Results exhibited higher flow rates and plaque indices on both the roughened and polished inlays compared to fluid collected from a non-restored area. Planimetric asseys of the plaque did, however, show more plaque on the roughened inlay sites. It was their estimation "even perfectly adapted and well polished proximal gold inlays cause gingival inflammation."

Holm-Pedersen et al. (1975) examined the production of experimental gingivitis in young (20-24 years) and elderly(65-78 years) individuals. During the abstention (21 days) of oral hygiene procedures the patients were observed and a gingival index assesment (Löe and Silness, 1963) was effected. A plaque index (Silness and Löe, 1964) was also assesed. After the experimental period, a complete prophylaxis was done and oral hygiene procedures were reinstituted. The gingival conditions were again assesed and recorded. Results demonstrated elderly individuals accumulated plaque more rapidly and severly. Gingivitis was also more pro-

nounced in the elderly. A microscopic count of the various microorganisms did not reveal any significant differences between groups. Return to gingival health occured at the same rate for both groups. The opinion of this group thus stated: "indicate that with age there is an altered host response to the microorganisms of the plaque."

An in depth study of the permeability of the oral mucosa was presented by Squire and Johnson (1975). The oral mucosa, they reported, is not a highly permeable membrane and most substances pass across by simple diffusion in which "the rate of penetration is directly proportional to the concentration of penetrant." The permeability of the sulcular epithelium is enhanced by the presence of plaque which institutes an inflammatory response thus creating an area for transmission "of large-molecular weight substances from local external milieu." They theorized the crevicular exudate, which contains the emigrating leukocytes, exited from the tissue via the junctional epithelium. Research indicated there was no intercellular barrier in the junctional epithelium, therefore, exogenous substances also entered via this pathway. Conclusively they stated: 1) "Even in the intensely studied gingival area, we have little information concerning the intrinsic permeability of this tissue, 2) there are a large number of potentially

useful drugs that have not yet been used in this way (topical application) their application awaits a better understanding of mucosal permeability."

With continued interest in the mechanisms of gingival crevicular flow Golub and Kleinberg (1976) supported and agreed with Alfano's (1974) hypothesis of an osmotic-gradient, caused by plaque by-products, initiating crevicular fluid flow. They, however, speculated these by-products (bacterial metabolism and degradation) increased the flow by directly affecting the epithelium and underlying connective tissue. They recommended more investigation regarding the role of non-ionized ammonia and urea in the initiation of crevicular flow. They evaluated various methods of fluid collection and determined the use of the gingival crevicular flow meter (Periotron) to be the most efficient and effective. In their judgement monitoring the flow could be a sensitive indication of sub-clinical gingival pathology. It could also be used objectively in measuring effective oral-hygiene and periodontal therapy. It was also suggested measurement of gingival crevicular fluid constituients might provide the basis for a screening technique in systemic diseases.

An evaluation of the HAR-600 Gingival Crevice Fluid Meter (Harco Electronics LTD., Winnipeg, Canada) and its usefulness in clinical application was presented

by Suppipat (1976). He tested and revealed variations in filter strip readings according to 1) location of filter strip placement between sensors, 2) viscosity of fluid being analyzed, and 3) temperature and humidity of area where readings took place. He proposed calibration of the machine, with each use, should be instituted. In this study he employed the orifice method (Löe and Holm-Pedersen 1965) of fluid collection. His findings were 1) none or very little fluid is found in clinically healthy gingiva, 2) "gingival inflammation has a stronger relationship with gingival fluid flow than has pocket depth" (in agreement with Mann 1963), and 3) there was a higher success rate after scaling when the pocket depth was 3mm or less. His conclusion was "gingival fluid measuring is sensitive and objective in evaluating the quality of gingiva close to the gingival margin (orifice method)."

In another study Jameson (1976) compared non-restored anterior teeth to contralaterally restored teeth. Pocket depth and crevicular fluid measurements were recorded and correlated. A positive correlation between amount of fluid flow and pocket depth was registered. He proposed sub-clinical inflammatory changes associated with sub-gingival margins can be quantitatively measured."

Crown Margination and Contouring

An histologic research was presented by Waerhaug (1960) investigating gingival irritation. He examined overhanging margins, rough surfaces, retained bacterial plaque to ascertain gingival reaction. His findings indicated the gingival irritation and/or inflammation was more likely due to plaque retention than mechanical or material irritation. He proposed the rough filling would accumulate plaque quicker than a smooth one; this accumulation then being the etiologic factor in periodontitis rather than the roughness per se. He considered placement of the gingival margin should be related to "Caries rate, predisposition to periodontitis, oral hygiene, and esthetics."

App (1961) histologically evaluated the subgingival response to amalgam, silicate and cast gold. Histologic examination was of intracellular hydropic degeneration, epithelial proliferation, and the presence of inflammatory cells. Implications were the amalgam and silicate restorations evidenced chronic inflammation while the tissues adjacent to the cast gold restorations showed "no pathologic tissue response."

An histological investigation by Marcum (1967) was presented comparing the gingival reaction of gold crown margins placed above, even with and below the

gingival crest on dogs. The analysis was on the number and types of inflammatory cells in the sub-mucosa and sulcular epithelium, the degree of vascularity, the presence or absence of epithelial proliferation, and the thickness of sulcular epithelium. It was demonstrated there was less inflammation around the tissues whose margins had been finished even with the gingival crest. Slight to severe inflammation occurred on the margins located above and below the gingival crest. The explanation for increased inflammation above the gingival crest was plaque formation and adherence of food debris; increased inflammation below the gingival crest "may be due to the minute crevice between the natural tooth structure and the margin of the gold, and to inadequately finished margins which result in plaque formation." The least inflammatory response, "may be due to a better marginal finish, and a better crown contour that deflects food away from the gingival crevice."

Löe (1968) proposed damage to gingival tissues occurred during restorative procedures of preparation, impression taking, and final cementation. Although often reversible it did not explain the progressive destruction of the periodontium adjacent to fillins or crowns. It was postulated "rough surfaces and ill fitting margins extending into the subgingival area are responsible for these pathologic events." He further

stated the subgingival margin was not only an irritant but also a place where bacterial plaque could harbor innumerable microorganisms. In conclusion he reiterated "it is evident that the concept of extension for prevention (regarding marginal integrity) is obsolete and should be revised."

Larato (1969) presented a random study on gingival margin extension and types or restorative materials utilized. The results of the investigation indicated a higher percentage of clinical gingival inflammation when the margin of the restoration was subgingival. Gold foil, it was noted, had the least percentage of gingival inflammation when the restoration was subgingival. He further stated: "Perhaps the meticulous procedure of finishing and polishing the margins and surfaces of the gold foil with good gingival retraction using the rubber dam, decreases the incidence of rough overhanging margins and surfaces which encourage the accumulation of food debris and bacterial plaque."

The restorative procedures relative to gingival tissue management for full crown coverage ia a constant concern of the restorative dentist. Mount (1970) presented a discourse which advocated supra gingival placement of crowns, except in areas where 1) esthetics are concerned, 2) retention, and/or 3) extensive caries are present. He discussed primary preparation of the gingi-

val tissues prior to crown preparations. It was his contention this is the most important phase in restorative procedures.

In 1973 Trivedi and Talim observed the gingival response to polished, unpolished, brushed and unbrushed amalgam, silicate, acrylic resin, and (Progold). Biopsies of the gingival tissues were made and evaluated according to the inflammatory response of the different restorative materials employed. In this study "the tissues contiguous to the (Progold) restorations showed no inflammation. However, there was epithelial proliferation in 83.3% of the specimens." Their conclusions were "(Progold) is biologically acceptable to the gingiva."

A paper pertaining to marginal fit of full cast crowns was presented by Eliasson and Lund (1974). The discourse related marginal fit to the interface between the casting and the prepared tooth. They suggested internal relief, venting and burnishing as ways to improve marginal fit.

An article presented by Nemetz (1974) discussed techniques and instrumentation to follow for porcelain-metal crown restorations. His primary concern was minimizing trauma to the gingival tissues, with judicious use of electrosurgery, proper bevel placement, alum-sulfate for retraction procedures and properly contoured provisional restorations. He stressed gingival tissue

management prior to final reconstructive procedures.

The skepticism regarding placement of crown margins prompted a query by Newcomb (1974). He designed a research which investigated the degree of inflammation in tissues surrounding crown margins restored at different levels in the gingival sulcus. Porcelain jacket crowns and porcelain fused to metal crowns were used in the study. Results exhibited an increased inflammation around crowns with subgingival margins. He postulated: "The nearer a subgingival crown margin approaches the base of the gingival crevice, the more likely it is that severe gingival inflammation will occur. The least inflammation is observed when subgingival crown margins are placed at the gingival crest or just into the gingival crevice." This supported the research by Marcum (1967).

Further examination of crown margin placement was effectuated in a three year (1970-1973) longitudinal research at the University of Oslo. Comparison of subgingival margins to supra gingival margins was investigated. Ramfjord et al. (1974) reported the findings. It was disclosed from this report subgingival margins cause more severe gingivitis, increased pocket depth, and more loss of epithelial attachment. Other results were 1) "Subgingival placement of margins did not give the anticipated protection against caries." 2) gingival recession occurred and increased proportionately with

management prior to final reconstructive procedures.

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time when provisional restorations were used beyond their limits, and 3) foreign body reaction potential was increased due to sulcular epithelial removal prior to impression procedures.

A study on 111 male veteran patients was performed by Larato (1975). This investigation was to determine "whether cast crowns with subgingival margins are more frequently associated with pathologic pocket depths than are non-restored contralateral teeth." A comparison of tooth brushing frequency related to pocket depth was also analyzed. His results suggested 1) restored teeth had 47% deeper pocket depth than non-restored teeth, 2) no relationship between pocket depth and the frequency of brushing, 3) reduced brushing frequency resulted in increased pocket depth of non-restored teeth, and 4) there was an increase in pocket depth in conjunction with an increase in patients age (restored or non-restored teeth).

Morris (1962) reviewed and discussed "the problem of minimizing gingival irritation as related to the axial contours of artificial crowns." He described philosophies of the various contours which could be fabricated. He refuted the theory of a buccal and lingual bulge created to "deflect the food over the crevice and on to the keratinized surface of the attached gingival tissues." Over contoured crowns are unphysiologic and unnatural and

cause increased gingival destruction. He speculated it is muscular activity which controls the action of food in the mouth. He further suggested if crown contours were more physiologic to flat, the muscular activity (which controls the action of the food in the mouth) would promote better gingival health.

Natural tooth contours for the increased maintainability of oral hygiene was advocated by Burch (1971). He presented a concise guide of gingival-coronal, facio-lingual, contact areas, and sub/supra gingival marginal contour relationships. It was his opinion "proper coronal contours and proper tooth alignment lend to an individual and collective self protection of the masticatory apparatus."

Gold and Precious Metal Alloys

The introduction of metallic compounds into the oral environment necessitates considerations regarding tarnish and corrosion. Saliva, being a weak electrolyte, provides a medium in which this can occur.

An in vitro study (Swartz, Phillips, El Tannir 1958) of amalgam, gallium, and gold was conducted to determine the chemical nature of these alloys in various concentrations of ionic solutions simulating oral conditions. After the 66 day test, results demonstrated a high degree of tarnish for amalgam in a 0.5% Na_2S solu-

tion. Synthetic saliva, 0.5% NaCl, and H_2O exhibited less discoloration. Gallium evidenced less effect from synthetic saliva and Na_2S while a more pronounced tarnish was visible from NaCl, H_2O and H_2O_2. No discernible tarnish was detected on gold alloys in any of the media used.

Tuccillo and Nielsen (1971) reported on an investigation of sulfide tarnish on 14 gold-base alloys. The alloys in this research were first tested for microscopic tarnish from a synthetic saliva solution. As previously reported (Swartz et al. 1958) no microscopic tarnish developed on these alloys from the synthetic saliva solution. It was detected on all castings from the 0.5% Na_2S aqueous solution there formed an "incipient tarnish by a microscopically visible surface reaction product of some kind."

An experiment by Leirskar and Helgeland (1972) was devised to test the biocompatibility of dental materials by testing animal cell 1) growth in close proximity to the dental material and 2) adherence to the surface of said material. The materials (gold, amalgam, copper amalgam, heat cured acrylics, silicate, and composite) were incubated with mouse fibroblast cells (L929) and human epithelial cells (NCTC). Resultant growth in the presence of gold was similar to that obtained in control cultures. There was varying cytotoxic effects for the other materials with the heat cured acrylic

shown to be the next most compatible (a transient toxic effect was observed at first), silicates followed by silver amalgam were next observed. Composites and copper amalgam appeared to have a general toxic effect.

The use of the Vickers hardness test has recently been adopted by the American Dental Association. This encouraged the investigation by Barton et al. (1973) for determination of a relationship between Brinell hardness numbers and Vickers diamond pryamid numbers for dental gold casting alloys. An extensive testing method was instituted and completed. Also researched was the validity of the Vickers test compared to the Brinell test. No verification that one test was more precise than the other was evidenced. No effect from surface preparation, grain size, and grain structure was apparent on the precision of the method of testing. Indications were "if 19 is added to the Brinell number the Vickers number is approximated fairly well."

A pilot study was initiated in 1973 by Burnell and O'Connell to compare laboratory differences versus in vivo results on the attritional characteristics of Types A and D cast gold. Results intimated a faster wear ratio on a gold casting with a higher Brinell hardness. There was a significantly higher loss on the in vivo castings. No hypothesis for these results was suggested.

A review of the literature by Dahl (1974) regarding biological compatibility of "some materials commonly used in crown and bridge prosthetics" was expressed. Among these materials was gold. He stated toxicity tests of oral tissues was critical and proposed "a demand that such tests (in vitro) be carried out before introducing altered or new materials does not seem unreasonable and it should be the responsibility of the manufactures that this demand be complied with."

In 1974 Huget and Civjan reported on silver-palladium alloys. At that time there was little information available. They did, however report: "Dental alloys containing relatively large amounts of palladium and silver and a small amount of gold can be rendered susceptible to precipitation or age hardening by the addition of small amounts of other metals such as copper." Also the addition of low-melting base-metals such as zinc, indium, or tin would increase the fluidity of the molten alloy and thereby improve its castibility. Their stated position was "Since sufficient data based on reliable long-term observations of fixed prostheses fabricated from palladium-silver-based alloys are not available, the clinical efficacy of these materials cannot be ascertained." They advised research in four areas: 1) accuracy of fit, 2)assesment of corrosion resistance, 3) refinement of laboratory techniques, and 4) asses-

ment of porcelain bond strength to high palladium-content alloys.

Sandrik et al. (1974) investigated the biocompatibility of four commercial Nickel-base (80%) alloys. The alloy was implanted in rabbit muscle for periods of 2-54 weeks. A stainless steel implant was used as a control. Histologic assesment was made for 1) thickness of connective tissue capsule, 2) type and degree in inflammatory response, 3) presence of foreign body giant cells, 4) presence of corrosion products, 5) presence of eosinophiles, 6) pathology of surrounding muscle, and 7) presence of adipose tissue. The most prominent feature was the deposition of adipose tissue. This was described as an inflammatory reaction followed by removal of toxins with a consequential replacement of inflammatory tissue by adipose tissue. Although the corrosion rate in this study was not excessive the possibility of continued metalic ion deposition over a period of time may be of clinical significance. They stated "An absolute determination of biological acceptibility of an implanted material is extremely complex and, unfortunately subjective." Thus, they indicated: "The nickel-base dental alloys appear to be significantly more reactive than type 316L stainless steel."

Gourley (1975) compared type III gold alloy to lower gold content and silver-palladium alloys as to

accuracy of fit, burnishability, tarnish resistance, esthetics, and casting and technical manipulation. Burnishibility depended on percentage of elongation, yeild strength, and hardness. With a lowered gold content the alloys became harder, had an increased yeild strength, and demonstrated a decreased percent elongation. These alloys therefore, were more difficult to burnish. The lowered gold content and silver-palladium alloys did give a less accurate fit than the Type III gold alloys, but did fall within a clinically acceptable range. The manipulation of these alloys was the same as for Type III gold alloy. The silver-palladium alloys were less costly than gold alloys. In addition these alloys had a lowered density which would allow for more castings per ounce. Thus substantial savings could be achieved. It was his opinion: "With extra care in fabrication the low gold content and precious alloys may be clinically acceptable but there is more chance that the work will need repeating."

A paper which discussed burnishability of casting alloys was submitted by Moon and Modjeski (1976). It was their observation the new precious metal alloys had a higher yield stresses and were harder than the Type III gold alloys which meet ADA specifications. "These properties also would indicate alloys that are harder to burnish. Though burnishing a casting is not

preferred to a casting that fits well, burnishing can compensate for some of the marginal errors which inadvertently occur in casting procedures." Knowing various mechanical properties of alloys allows for recognition of clinical reactions. They have proposed a formula by which a burnishability number could be arrived at: Burnishability # = $\frac{\text{BHN}}{\% \text{ elongation}}$. "The higher the burnishability number, the harder the alloy is to burnish."

Schulman et al. (1976) prepared a gold-nickel (77% gold) alloy and tested it metallurgically and clinically. The alloy had a yeild strength of 7400 Kg/cm^2 and an elongation of 12%. Twelve volunteers, six with partial dentures and six with crown and bridge prosthesis, were clinically tested. In 2½ years there were no adverse tissue reactions, no corrosion, tarnish, or discoloration, no observation of systemic toxicity, and no broken clasps due to any required adjustments. Their conclusions were this alloy had the combined physical and mechanical properties and clinical desirabilities of both gold and cobalt-chrome alloys.

The present ADA classification of alloys for use in restorative procedures is noble (those containing a specific % of gold and/or platinum), precious (those alloys containing a predominance of silver and palladium), and non-precious (the base-metal alloys, primarily cobalt-chrome, nickel, and tin). Metals which

are used in varying degrees in restorative dentistry are gold, platinum, silver, palladium, copper, tin, nickel, iron, chrome, cobalt, and zinc. This list progresses from the most noble metal, gold, to the "non-noble" metals toward the end. As suggested by Duncanson (1976) it may conceivably be more accurate and concise to classify dental alloys used for casting procedures into catagories of noble, semi-noble, and non-noble. "Alloys fulfilling the ADA specification #5 would be considered noble; those with a significant reduction in gold content or containing predominantly silver and palladium, semi-noble, and those of chromium, cobalt, nickel or iron, non-noble."

At the present time the Council on Dental Materials and Devices has one certification program. This is a program to improve and maintain the standards and qualities of certain materials and devices used in the practice of dentistry. Under the auspices of this program the manufacture of a dental material certifies his product complies with the specifications which have been approved as official "Specifications of the ADA". For dental casting gold alloys this is specification number five. To receive this certification the metals are subjected to various testing procedures. Most manufactures of Types I thru IV gold alloy have this certification.

The acceptance programs applies to materials and

devices for which evidence of safety and usefulness has been established by biological, laboratory and/or clinical evaluations, but where physical standards or specifications do not currently exist. There are now three of these programs relative to precious and base-metal alloys. The first two acceptance programs were proposed for base-metal alloys and the silver-palladium alloys. The new acceptance program, recently submitted (1976), will include the previous two catagories and in addition the so called "economy golds". The new program is considered as an ad interim until a physical specification is adopted. Subsequently such products will be transferred to the certification program of the council.

CHAPTER III

MATERIALS AND METHODS

The ten patients participating in this investigation were selected from patients at Loyola University Dental School and from the private practice of the investigator. There were seven females and three males between the ages of fourteen and forty-nine (mean age of 31.5 years).

Tooth selection was based on need for full coverage castings in the posterior areas. These were prepared, mercaptan impressions were taken, (according to manufactures instructions) and the crowns were constructed. The restorations were all fabricated by the same technician. The alloy used was Type III casting gold or Albus IV precious alloy (Tables I & II). The crowns were cemented in place for a minimum duration of two months to a maximum of four years.

At the time of fluid collection all patients signed the consent form which described the procedure (Appendix A). A brief medical/dental history was recorded (no systemic diseases were evidenced). Measurements of pocket depth and the gingival index (after Löe and Silness 1967, see below) were assesed and registered (Table III, Fig. 1).

TYPE III GOLD*

COMPOSITION AND PHYSICAL PROPERTIES

Composition	BHN	Tensil PSI	Elng. %	Yield Pt. PSI	Melt T. F	Cast T. F.	Burn Out F
Au-Pt 78%	110	61,000	35	32,000	1650	1900	900
	165	69,500	18.5	51,500	1755		1200

*Ney Oro B-2 Appears on ADA List of Certified Products

Table I

ALBUS IV

COMPOSITION AND PHYSICAL PROPERTIES

Composition	BHN	Tensil PSI	Elng. %	Yield Pt. PSI	Melt T. F	Cast T. F	Burn Out F
Au .. 2.0% Ag .. 55.5% Pd .. 26.0% Cu .. 15.5% In .. 1.0%	153	70,500	11	54,500	1750	1925	1350
	220	104,000	4	90,000	1875		1400

Table II

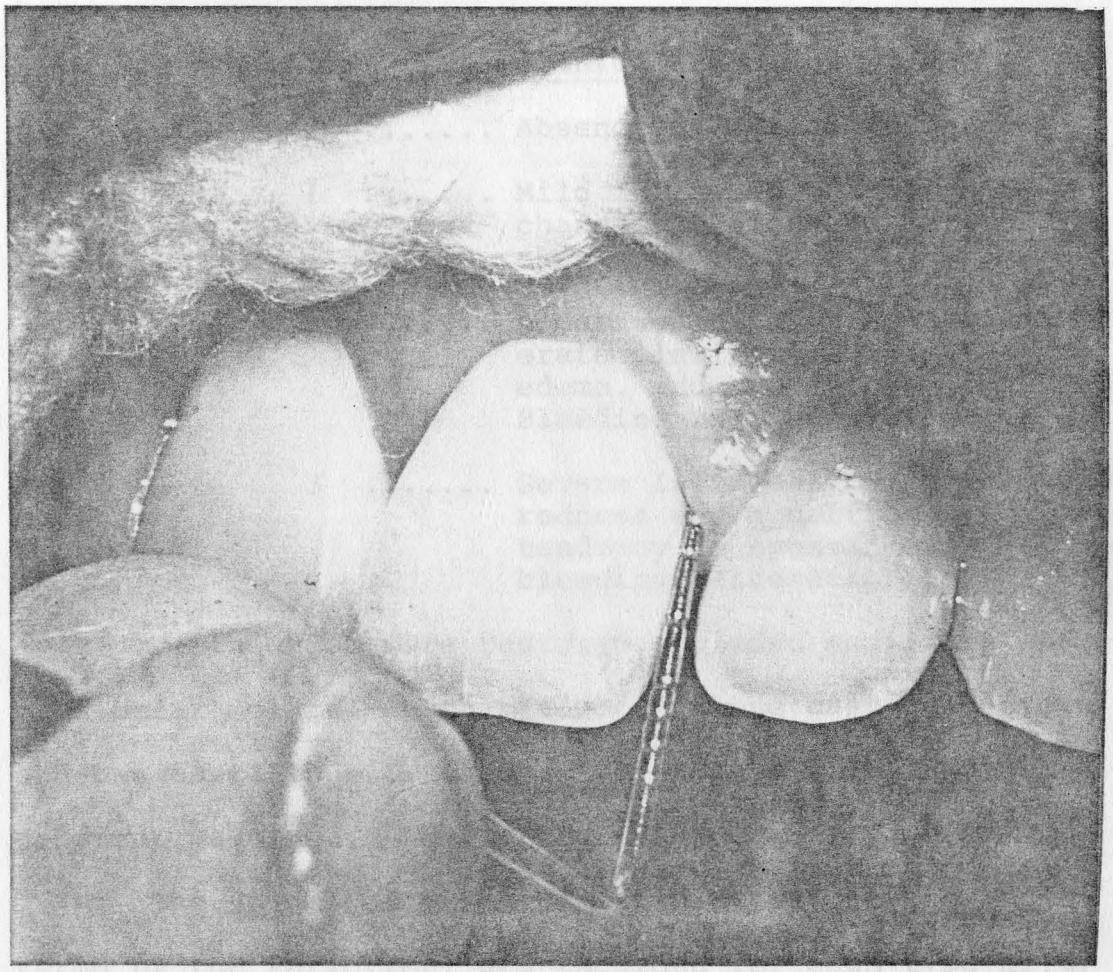

Figure 1. Pocket Depth Measurement with PDL Explorer

Gingival Index - Löe and Silness (1967)*

Score	Clinical Findings
0	Absence of Inflammation.
1	Mild Inflammation: Slight change in color and little change in texture.
2	Moderate Inflammation: Moderate glazing, redness, edema, and hypertrophy. Bleeding on pressure.
3	Severe Inflammation: Marked redness and hypertrophy; tendency to spontaneous bleeding; ulceration.

Teeth which were restored included maxillary and mandibular molars. Each patient had one cast gold crown and one cast Albus IV crown. All restorations had subgingival margins.

The volume of crevicular fluid present (as registered by the Periotron) was recorded for each type alloy utilized (Table III). Recent research (Borden et al. 1974, Golub and Kleinberg 1976, and Suppipat 1976) has indicated the Periotron to be the most acceptable instrument for crevicular fluid measurements (Fig. 2).

The measurements were taken by the intra-crevicular method (Löe and Holm-Pedersen 1965). Collection of the

* Gingival Index or G.I. in this paper refers to the clinical appearance of the marginal gingiva as evaluated by the investigator.

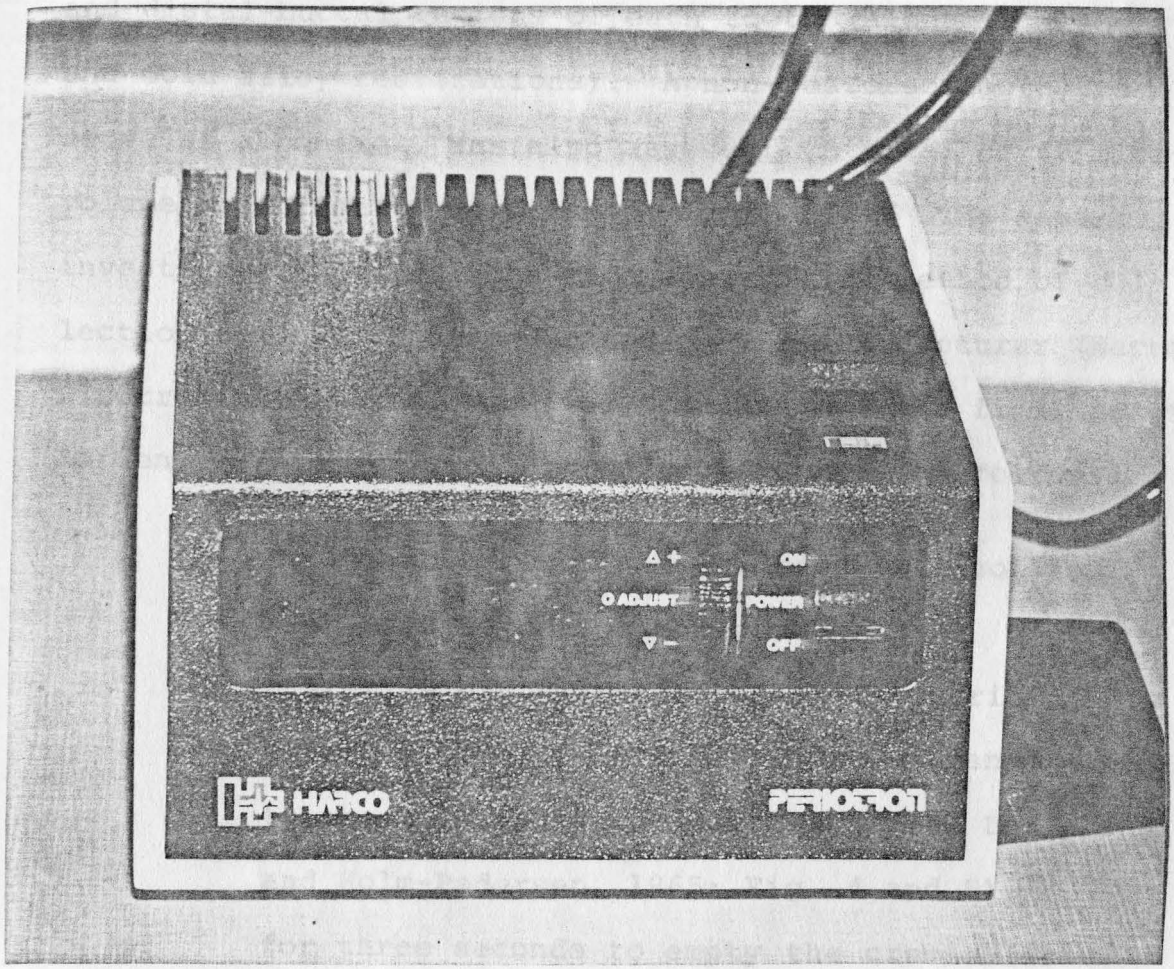

Figure 2. Periotron (Clinical GCF Meter)

sulcular fluid was with Periopaper* in the mesial-buccal and distal-buccal regions of each tooth (Albus IV alloy and Gold alloy restorations). A non-restored tooth, to serve as a control, was also assesed. A total of 66 fluid volume measurements were taken (Table III). The same investigator took all the recordings. The method of collection followed that indicated by the manufacturer (Harco Electronics Limited, Winnipeg, Canada; and the findings of Borden, 1974). The collection technique is as follows:

1. Region to be examined is dried and isolated with sterile cotton rolls.
2. A sterile dry filter paper strip (Periopaper, Fig. 3) is placed at the entrance to the gingival sulcus orfice (after Loe and Holm-Pedersen, 1965; Fig. 4 and 5) for three seconds to empty the crevicular pool. This filter strip is removed and discarded.
3. After a twenty-seven second interval, another sterile dry filter paper strip is placed at the sulcus orfice for three seconds. The total elapsed time is thirty seconds.

*Periopaper - Trade name for filter paper manufactured by Harco Electronics, Limited, Winnipeg, Canada. (1.5 mm. X 13 mm.).

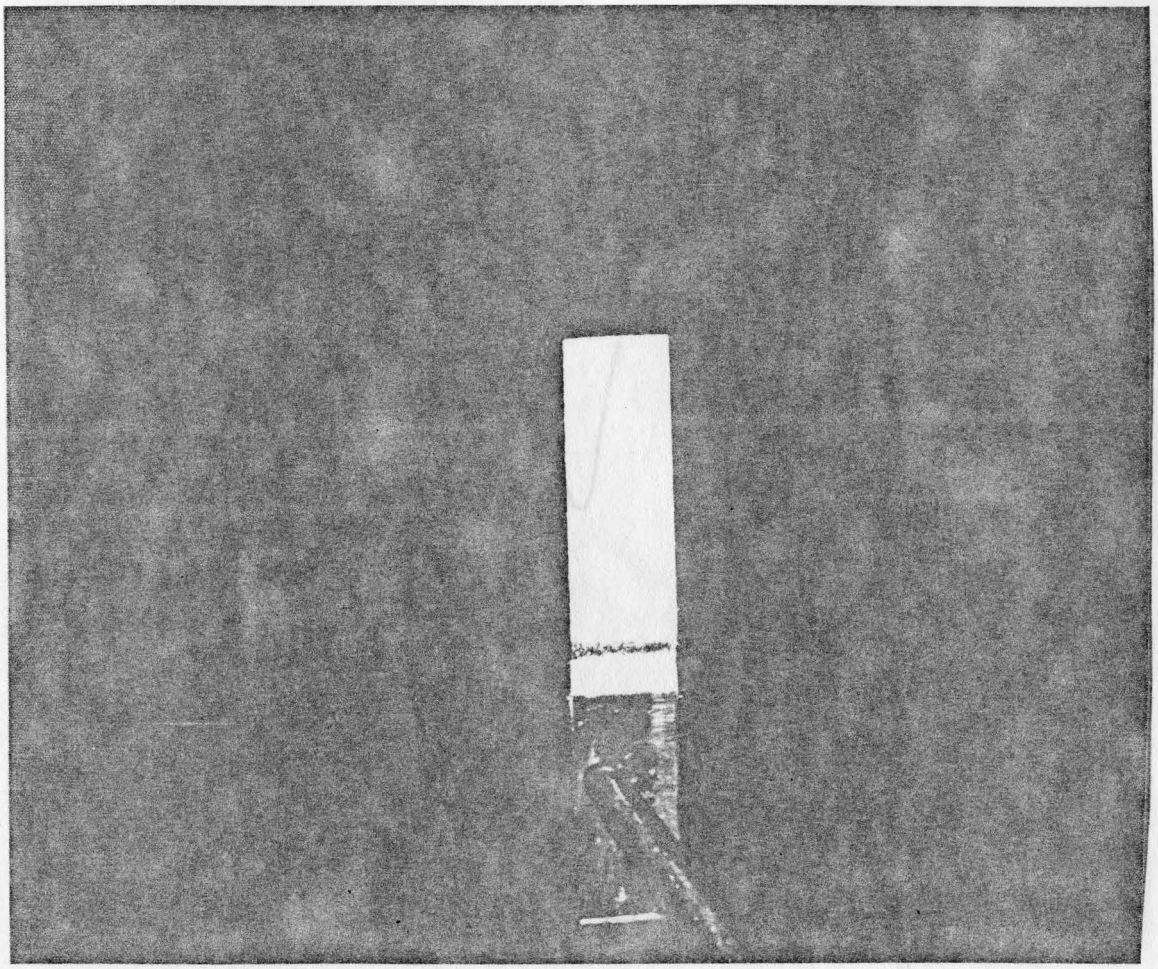

Figure 3. Filter Paper Strip Prior to Fluid Collection

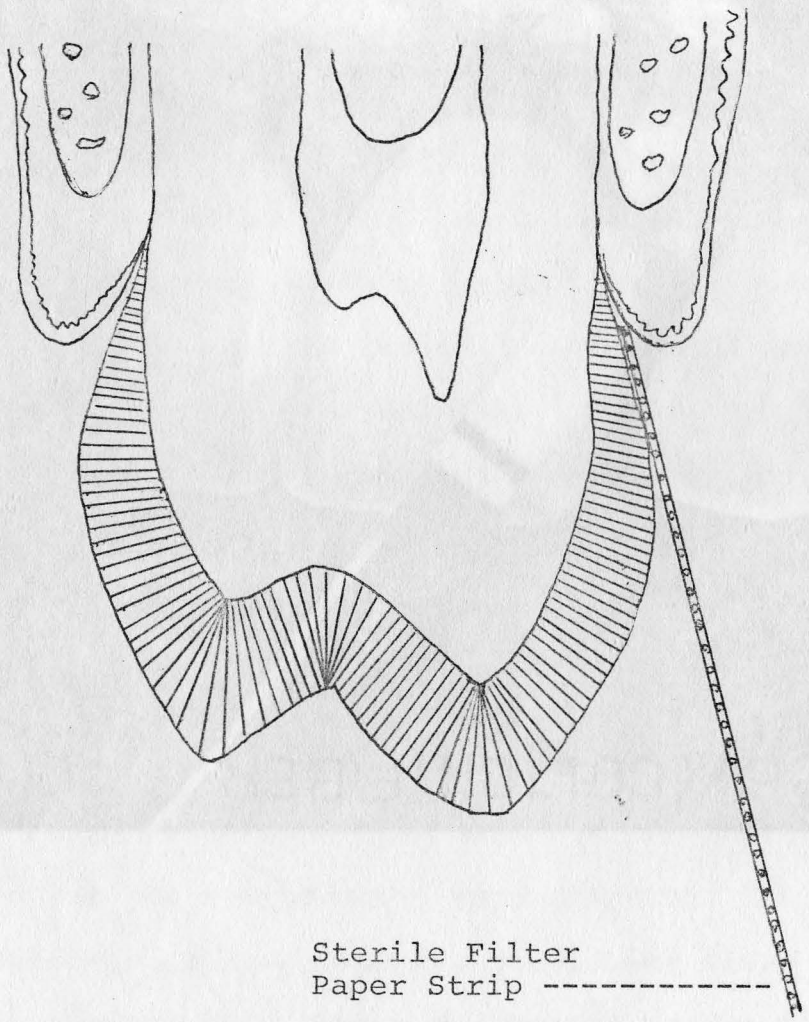

Figure 4. Intracrevicular Method for Fluid Measurement (After Löe and Holm-Pedersen, 1965).

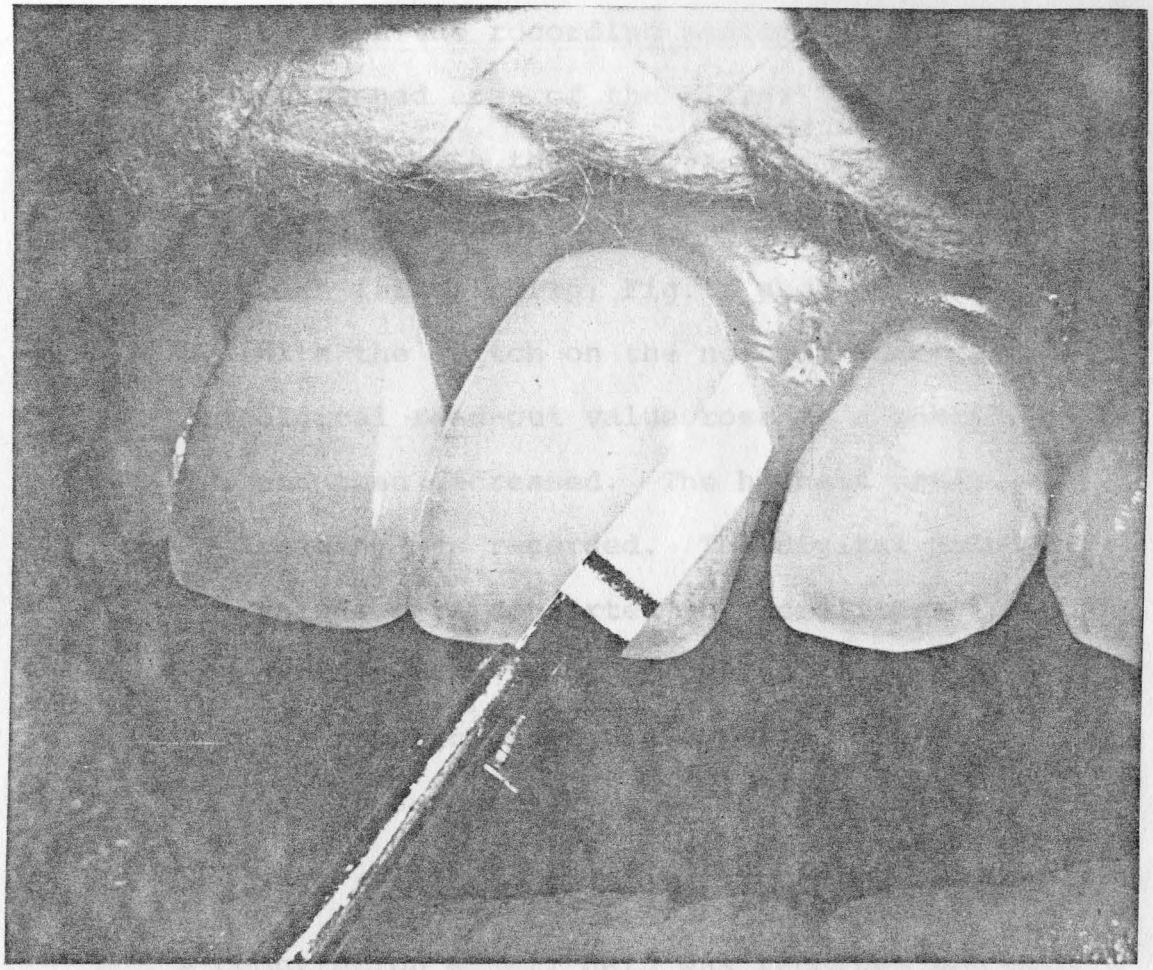

Figure 5. Collection of Crevicular Fluid

4. The filter papter strip was immediately placed between the rocording sensors so the entire moistened area of the filter strip was in contact with the sensors (the filter paper strip was inserted to the line marked on each filter strip; Fig. 6 and 7).
5. With the switch on the no-hold mode, the digital read-out value rose to a maximum and then decreased. The highest numerical reading was recorded. The digital numerical values were converted to microliters by dividing the readings by 200 (e.g. a digital reading of 20 = 0.10 ul).
6. After each measurement, the sensors were dried with a sterile cotton roll.

A compilation of all data was recorded and mean values for the measurements were computed. An analysis of variance was performed on the crevicular fluid measurements to ascertain a significant difference in the tissue response to the alloys used. The pocket depth measurements were also subjected to an analysis of variance to determine whether a significant difference in the readings between restored and non-restored teeth existed.

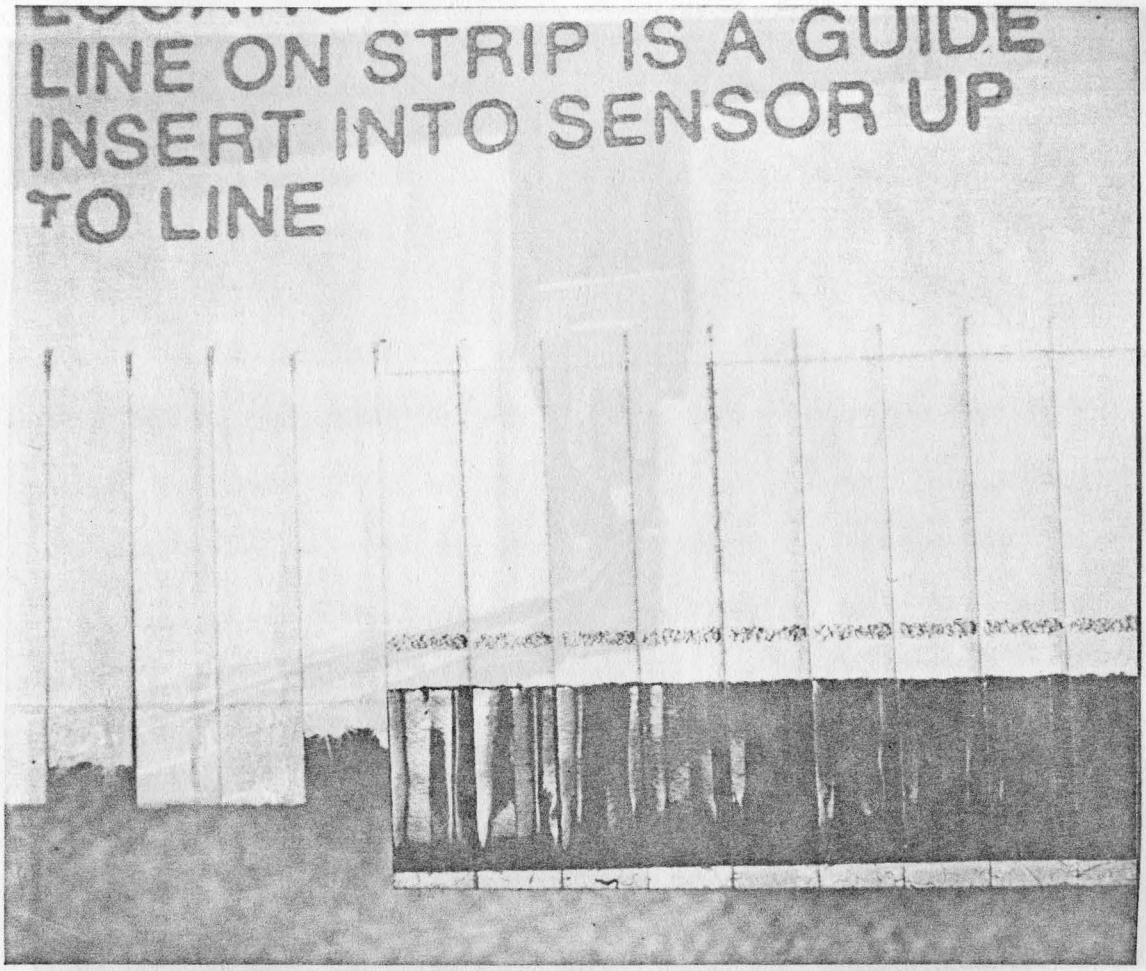

Figure 6. Holding Card for Filter Paper Strips

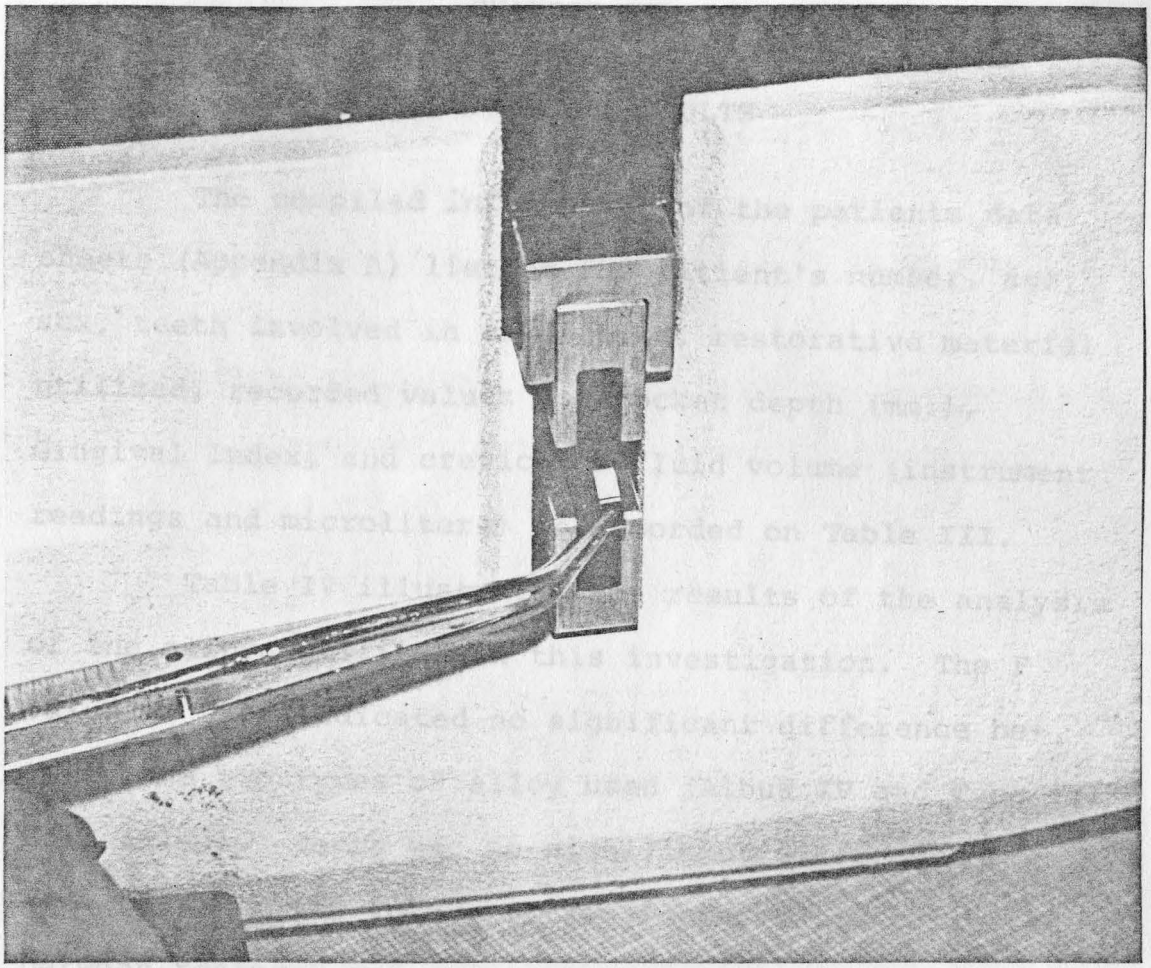

Figure 7. Placing Filter Paper Strip Between Sensors of GCF Meter

CHAPTER IV

EXPERIMENTAL RESULTS

The compiled information of the patients data sheets (Appendix A) listing the patient's number, age, sex, teeth involved in collection, restorative material utilized, recorded values for pocket depth (mm.), Gingival Index, and crevicular fluid volume (instrument readings and microliters) is recorded on Table III.

Table IV illustrates the results of the analysis of the alloys utilized in this investigation. The F value of 0.06 indicated no significant difference between the two types of alloy used (Albus IV and Type III Gold alloy). There was no significant difference ($F = 0.84$) in the volume of crevicular fluid collected between restored and non-restored teeth.

The analysis of variance performed on the pocket depths between restored and non-restored teeth is shown in Table V. A significant difference ($F = 4.12$) was evidenced. An F value of 0.93 in this analysis indicated no significant differences among the individuals existed.

Table VI is a summary of the mean values of the Gingival Index, pocket depth readings and the gingival crevicular fluid readings from restored and non-restored

teeth. No differences between the crevicular readings of the restored and non-restored teeth existed. There was, in fact, a higher reading on the distal of the non-restored teeth probably resulting from two readings taken in difficult third molar areas.

A clinical evaluation revealed no presence of tarnish or corrosion, nor was there any discernable difference in plaque build-up attributable to the two metals used. There were no complaints of metallic tastes or "galvanic shocks".

Patient Number	Age	Sex	Tooth #	Rest. Mat.	Mesial Fluid Volume	Mesial Ging'l Index	Mes. Pokt. Dep.	Distal Fluid Volume	Distal Ging'l Index	Dis. Pokt. Dep.	Fluid Vol. Ave	Mths. Rest.	ul
1	31	M	3	A	17	0	2	4	0	2	11.5	8	.0575
			14	G	10	0	1	4	1	1	7.0	8	.0350
			31		30	1	3	63	1	3	46.5		.2325
2	41	F	18	A	17	1	3	16	1	3	16.5	6	.0825
			31	G	27	1	3	26	1	3	26.5	5	.1325
			28		7	0	1	27	0	2	17.0		.0850
3	31	M	19	A	21	2	2	43	2	4	32.0	4	.1600
			18	G	33	2	3	19	2	2	26.0	4	.1300
			21		4	1	1	15	1	1	9.5		.0475
4	14	F	19	A	9	0	3	4	0	2	6.5	6	.0325
			14	G	3	0	2	19	0	3	11.0	4	.0550
			11		6	0	1	2	0	1	4.0		.0200
			30	A	20	0	3	4	0	2	12.0	11	.0600
			3	G	23	0	2	2	0	1	12.5	7	.0625
			6		2	0	1	11	0	2	6.5		.0325
5	42	F	30	A	22	0	2	2	0	2	12.0	8	.0600
			18	G	30	0	2	9	0	3	19.5	8	.0975
			20		24	0	3	5	0	2	14.5		.0725
6	21	F	30	A	24	0	2	19	0	2	21.5	4	.1075
			14	G	28	0	2	38	0	2	33.0	3	.1650
			12		11	0	1	6	0	1	8.5		.0425

Table III

Compiled Data

Patient Number	Age	Sex	Tooth #	Rest. Mat.	Mesial Fluid Volume	Mesial Ging'l Index	Mes. Pokt. Dep.	Distal Fluid Volume	Distal Ging'l Index	Dis. Pokt. Dep.	Fluid Vol.Ave.	Mths. Rest.	ul
7	32	F	31	A	8	0	2	9	0	3	8.5	13	.0425
			17	G	9	0	2	9	0	2	9.0	13	.0450
			21		12	0	1	14	0	1	13		.0650
8	16	F	19	A	30	0	2	19	0	2	24.5	3	.1225
			30	G	13	1	2	13	1	3	13.0	2	.0650
			21		10	0	1	4	0	2	7.0		.0350
9	31	M	30	A	15	0	1	16	0	2	15.5	48	.0775
			18	G	10	0	1	10	0	2	10.0	24	.0500
			20		12	0	0	5	0	1	8.5		.0425
10	49	F	3	A	10	0	2	8	0	3	9.0	2	.0450
			30	G	3	0	1	15	0	2	9.0	21	.0450
			31		15	0	2	36	0	3	25.5		.0275

Table III

Compiled Data

Analysis of Variance Table A

Variance Source	DF	SS	MS	F
Methods	2	11.70	5.85	.06
Subjects	10	842.08	84.21	.84
Intr.Act.	20	2014.47	100.72	
	32	2868.25		

Analysis of alloys

Table IV

Analysis of Variance Table B

Variance Source	DF	SS	MS	F
Methods	2	3.38	1.69	4.12
Subjects	10	3.80	.38	.93
Intr.Act.	20	8.29		
	32	15.47		

Analysis of Pocket Depths

Table V

Mean Values of Gingival Index, Pocket Depth, and GCF Readings

	Gold Alloy				Albus IV				Non-Restored			
	Mesial		Distal		Mesial		Distal		Mesial		Distal	
	Meter Read.	µl.	Meter Read.	µl.	Meter Read.	µl.	Meter Read.	µl.	Meter Read.	µl.	Meter Read.	µl.
	17.18	.086	14.9	.075	17.55	.088	13.09	.065	12.09	.06	17.09	.085
Ging. Index	0.36		0.27		0.27		0.27		0.18		0.18	
Pocket Depth (mm.)	1.90		2.18		2.18		2.45		1.36		1.73	

Table VI

CHAPTER V

DISCUSSION

The placement of crowns has always been a dimension of major consideration for the clinician mindful of the supporting structures of the masticatory system. The expanded interest in periodontal disease, its diagnosis and treatment, has led to careful reevaluation of restorative treatment. Comprehensive oral health requires integration of these two disciplines.

Gingival inflammation was one of the principal signs of periodontal breakdown. This is the host's response to noxious stimuli, bacteria, and/or foreign substances. An in depth study of recent and historical research indicated a relationship between gingival crevicular fluid and inflammation. (Cimasoni 1974). The use of crevicular fluid measurement to quantitatively monitor early changes in periodontal tissues had been suggested by Brill in 1960. Other investigations (Egelberg 1963a, Egelberg 1964, and Löe and Holm-Pedersen 1965) have demonstrated with an increase of fluid flow there is histological evidence of intensified inflammation. Inflammatory changes (PMN accumulation and microcirculatory alterations) have been reported in

clinically healthy marginal gingiva. The increased vascular permeability of the altered microcirculation results in an increase in the sulcular fluid. Thus early stages of inflammation can be quantitatively monitored prior to clinical evidence of periodontal disease and the subsequent destruction of the supporting tissues.

The Periotron was the instrument utilized for monitoring fluid flow in this study. In recent studies (Borden et al. 1974, Golub and Kleinberg 1976, and Suppipat 1976) this instrument was revealed to be the most acceptable for recording changes in fluid volumes.

Indications of an early inflammatory response to restorative procedures have been quantitatively demonstrated in this study. The measurements recorded, indicating an inflammatory response, are in agreement with other studies of full coverage restorations with subgingival margins (Marcum 1967, Larato 1969, Newcomb 1974, and Jameson 1976). No significant differences of fluid volumes between full gold alloy coverage and full Albus IV alloy coverage were registered, suggesting no differences in the gingival reaction (sub-clinical inflammation) between the gold alloy and Albus IV alloy. These findings are in accordance with the hypothesis of the investigator.

A significant difference in pocket depth measurements between restored and non-restored teeth did exist.

These findings indicate a positive relationship between sub-gingival placement of crown margins and increased pocket depth.

A statistical difference between restored and non-restored teeth was expected, but no such differences were recorded in this study. This may be explained, in part by the small number of subjects. The unavailability of an adequate area for fluid collection of the non-restored tooth was another consideration. There were two posterior (third molars) areas where fluid collection was very difficult and quite possibly contaminated with saliva. All the mouths manifested a clinically good periodontal profile. There were no untoward results exhibited from the two metals utilized.

Previous investigations (Holn-Pedersen et al. 1975, Golub and Kleinberg 1976) have indicated the initiation of an inflammatory response is ostensibly a manifestation of plaque accumulation and there was no clinical differences in this accumulation between the two metals employed in this study. The foregoing considerations are important to the restorative dentist and unless further research can determine some other dangers, Albus IV appeared to be a physiologically acceptable metal for use in dental restorations. The Periotron, as used in this study, was a valuable adjunct making it possible to monitor the patients for early periodontal

changes. These early changes were indicative of a sub-clinical inflammatory response.

Other areas of research suggested are:

1. Continuation of this study.
2. A study using the Periotron to evaluate and correlate GCF readings to pocket depth and plaque accumulation aroung subgingival crown margins.
3. In vitro studies of tissue reactions to the Albus IV alloy.
4. Studies to test physical properties of Albus IV
5. Longitudinal study to monitor crevicular flow prior to, during, and post operative to restorative procedures.

CHAPTER VI

SUMMARY AND CONCLUSIONS

A pilot study comparing crevicular fluid volumes between two alloys (Albus IV and Type III Gold alloy) and non-restored teeth was researched on ten patients between the ages of 14 and 49. Fluid collection was by means of sterile filter paper strips, (Periopaper); measurements of fluid volumes were determined by the Periotron.

Pocket depth and Gingival Index measurements for these teeth were also examined and recorded.

Gingival inflammation caused by margination, crown contouring and plaque indices was investigated and discussed.

Studies of various alloys and their reactions (in vitro and in vivo) were reviewed and suggestions for further studies were recommended.

From this study of the reactions of two different alloys (Albus IV and Type III Gold) the following conclusions were reached.

1. There was no statistically significant diffenence in marginal fluid flow between

an Albus IV full coverage restoration and a Type III Gold alloy full coverage restoration.

2. Sub gingival margins illicited a measurable crevicular fluid response indicating a sub-clinical inflammatory response. This was confirmed by recent research (Marcum 1967, Newcomb 1974, Ramfjord et al. 1974, and Jameson 1976). It has, therefore, been recommended subgingival margins be avoided where possible.
3. The chief cause of sub clinical and clinical inflammatory response in the crevicular area appeared to be plaque depositions and this did not vary with the two alloys utilized.
4. A significant difference in pocket depth between subgingivally restored teeth and non-restored teeth existed.

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APPENDIX

LOYOLA DENTAL SCHOOL

Fixed Prosthodontics Department

Crevicular Fluid Volume Measurements

PATIENT CONSENT FORM

The purpose of this study is to determine if there is an increase in the amount of fluid flowing from the space between the teeth and gums after placing a crown (cap).

This preliminary study will utilize an instrument that measures very small amounts of fluid and possibly can be used to detect gum disease before it has progressed to an advanced stage. Therefore, this procedure could be beneficial to participating patients by demonstrating the presence or absence of early periodontal disease. The procedure will involve isolating the teeth with sterile cotton rolls, then placing a small sterile piece of filter paper next to the teeth near the gums for about three (3) seconds. Several teeth will be measured in this manner. This will not produce any discomfort or have any ill effect whatsoever on the gums or the teeth. The entire procedure, including filling out the questionnaire, should take approximately twenty (20) minutes.

You are free at any time to ask questions about this project and the associated procedures. If during the procedure you wish to withdraw your participation in this study, you may do so without prejudice.

I HAVE READ THE ABOVE INFORMATION AND WILL PARTICIPATE IN THIS STUDY.

PARTICIPANT'S SIGNATURE _____

DATE _____

WITNESS SIGNATURE _____

DATE _____

LOYOLA DENTAL SCHOOL

FIXED PROTHODONTICS DEPARTMENT

CREVICULAR FLUID VOLUME MEASUREMENTS

Patient_____ Operator_____

Address_____ City_____ State_____

Phone No._____ Age_____ Birth Date_____ Zip_____

Tooth #	R. Mat.	M. Res'd.	Poc't. Depth (mm)	G. I.	Vol.

Key:
M - Mesial
D - Distal
R. Mat. - Restorative Material
G - Gold
A - Albus IV
N - Non-Restored
M. Res'd. - Months Restored
Poc't. - Pocket Depth
Vol. - Crevicular Fluid Volume measurements

G. I. - Gingival Index (After Loe & Sillness-J.Perio. 38; 610, 1967)
0 - Normal Gingiva
1 - Mild inflammation, slight change in color' slight edema, no bleeding on probing.
2 - Moderate inflammation, redness, edema, and glazing; bleeding on probing.
3 - Severe inflammation, marked redness and edema; ulceration; tendency to spontaneous bleeding.

LOYOLA DENTAL SCHOOL

Fixed Prosthodontics Department

Crevicular Fluid Volume Measurements

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I HAVE READ THE ABOVE INFORMATION AND WILL PARTICIPATE IN THIS STUDY.

Participant's Signature _____

Date _____

Witness Signature _____

Date _____

LOYOLA DENTAL SCHOOL

Fixed Prosthodontics Department

Crevicular Fluid Volume Measurements

Patient_____Operator_____

Address_____City_____State_____

Phone NO._____Age_____Birth Date_____Zip_____

Tooth #	R. Mat.	M. Rst.	Pokt. Dep. (mm)	G.I.	Vol.

Key:
M - Mesial
D - Distal
R. Mat. - Restorative Material
G - Gold
A - Albus IV
N - Non-Restored
M. Rst. - Months Restored
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G.I. - Gingival Index (after Loe & Sillness 1967)
0 - Normal Gingiva
1 - Mild inflammation, slight color change, slight edema-no bleeding on probing.
2 - Moderate inflammation redness, edema and glazing, bleeding on probing.
3 - Severe inflammation, marked redness, edema ulcers, bleeding

APPROVAL SHEET

The thesis submitted by Hanne T. Sweetnam has been read and approved by the following committee:

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Dr. Patrick Toto
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The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval by the Committee with reference to content and form.

The thesis is, therefore, accepted in partial fulfillment of the requirements for the degree of Master of Science in Oral Biology.

5/9/77
Date

William T. Malone
Director's Signature